

# Implementation of an innovative, integrated electronic medical record (EMR) and public health information exchange for HIV/AIDS

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Received 31 May 2011

Accepted 4 September 2011

Published Online First

28 October 2011

## ABSTRACT

Louisiana is severely affected by HIV/AIDS, ranking fifth in AIDS rates in the USA. The Louisiana Public Health Information Exchange (LaPHIE) is a novel, secure bi-directional public health information exchange, linking statewide public health surveillance data with electronic medical record data. LaPHIE alerts medical providers when individuals with HIV/AIDS who have not received HIV care for >12 months are seen at any ambulatory or inpatient facility in an integrated delivery network. Between 2/1/2009 and 1/31/2011, 488 alerts identified 345 HIV positive patients. Of those identified, 82% had at least one CD4 or HIV viral load test over the study follow-up period. LaPHIE is an innovative use of health information exchange based on surveillance data and real time clinical messaging, facilitating rapid provider notification of those in need of treatment. LaPHIE successfully reduces critical missed opportunities to intervene with individuals not in care, leveraging information historically collected solely for public health purposes, not health care delivery, to improve public health.

## INTRODUCTION

Louisiana is severely affected by the HIV/AIDS epidemic, with a rate of 19.4 new AIDS cases per 100 000 population in 2009.<sup>1</sup> Its two most populous metropolitan areas (Baton Rouge and New Orleans) rank second and ninth in AIDS case rates, respectively, among large metropolitan areas in the USA.<sup>1</sup> Statewide data estimate that over a third of HIV-infected individuals do not receive HIV specialty care.<sup>2</sup> Without treatment, infected individuals experience disease progression more rapidly and are at increased risk of transmitting the disease to others.<sup>3-4</sup> Current studies<sup>5-7</sup> demonstrate that successful maintenance in care with antiretroviral treatment for HIV-infected patients is critical in slowing the epidemic as well as for individual health, yet challenges in identifying and retaining patients in treatment remain. Electronic health information exchange (HIE) offers a provider-acceptable means of utilizing information from multiple sources<sup>8-15</sup> and could help overcome the challenges of engaging HIV patients in care.

As a part of its efforts to reduce HIV transmission, a novel public HIE was developed in Louisiana, using public health surveillance and electronic medical record (EMR) data to identify, in real-time, HIV-infected patients without adequate clinical

monitoring. EMR-based alerts notify providers whenever these individuals access care for any reason at one of the participating healthcare facilities, enabling immediate linkage into HIV treatment.

In 2007, the Louisiana Office of Public Health (OPH) partnered with the Louisiana State University Health Care Services Division (LSU HCSD) to determine if individuals not receiving CD4 or viral load monitoring for >12 months were seeking medical care for non-HIV-related conditions. The analysis revealed that ~1100 such individuals had received at least one non-HIV related service at LSU HCSD hospitals' emergency departments or clinics since their HIV diagnosis. During clinical encounters, the patient's HIV diagnosis information was not readily available to the clinicians, suggesting visits were missed opportunities to deliver appropriate care or referral to HIV specialty care while the person was in the healthcare setting.

LSU HCSD is an integrated delivery network (IDN) of seven safety-net hospitals providing over 1.4 million outpatient encounters and over 70 000 inpatient admissions each year. It is Louisiana's largest provider of inpatient and ambulatory HIV medical treatment, serving an estimated 60–75% of individuals receiving HIV medical care in Louisiana. Based on the 2007 match study, OPH and LSU HCSD hypothesized that bi-directional exchanging information between healthcare providers and public health systems would be an effective means of identifying and linking hard-to-reach HIV-infected individuals into care.

## CASE DESCRIPTION

The Louisiana Public Health Information Exchange (LaPHIE) is a secure bi-directional public health informatics application (an HIE in a broad sense, as defined by Dixon *et al*<sup>16</sup>), linking statewide public health surveillance data with patient-level EMR data. The exchange functions in real-time throughout the IDN's emergency departments, primary care and specialty ambulatory clinics, and inpatient units. LaPHIE represents an innovative exchange harnessing and integrating public health data to trigger real-time clinical decision support (CDS) to avoid missed opportunities for clinical and public health intervention.

## METHODS

### Approach

Work flow analyses identified opportunities for creating comprehensive linkage of information



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from diagnosis of HIV infection and reporting, to follow-up across public health and medical providers for HIV/AIDS, leading to a reduction in patients being out of care. The approach was to develop a secure data exchange that allowed individuals presenting in the IDN's hospitals and clinics who were not receiving adequate monitoring or treatment for HIV disease to be immediately identified. For example, when a patient who has been identified by LaPHIE as out of care for HIV for >12 months presents to the emergency department for an asthma exacerbation, real-time LaPHIE CDS logic triggers an alert within the workflow of nurses and physicians accessing the IDN's in-house developed EMR known as CLIQ (for CLinical InQuiry).<sup>17</sup> This point of service LaPHIE alert contains notification to the provider that the patient is in need of HIV treatment, patient-specific public health advice, and clinical recommendations (eg, assessment of symptoms, confirmatory testing, need for referral into care, tool for discrete documentation of actions, etc) to address the out-of-care patient's diagnosis. Recommendations are intentionally designed to support clinicians who may be unfamiliar with the management of HIV. This system adopts a 'no wrong door' approach so that untreated individuals with encounters anywhere in the IDN can be treated and/or referred, irrespective of their initial point of clinical service.

#### Development of the LaPHIE data set

Public health legislation in Louisiana mandates the reporting of communicable conditions such as HIV. Names-based reporting of HIV infection has been in place in Louisiana since 1993 and all public and private laboratories and healthcare providers are mandated to report results consistent with reportable communicable diseases. OPH, through laboratory surveillance, receives and confirms reports of new HIV infections, and quantifies a population of persons deemed 'out of care'—those who have never entered care or those who have dropped out of care as measured by an absence or interruption of CD4 or viral load testing for >12 months in laboratory surveillance data. Criteria have been developed using first order logic to create the LaPHIE out-of-care data set. These criteria are purposefully conservative, erring on the side of avoiding unnecessarily characterizing

a person as out of care. This data set of out-of-care persons populates the OPH database which interfaces via the LaPHIE system with the IDN's patient registration and EMR systems.

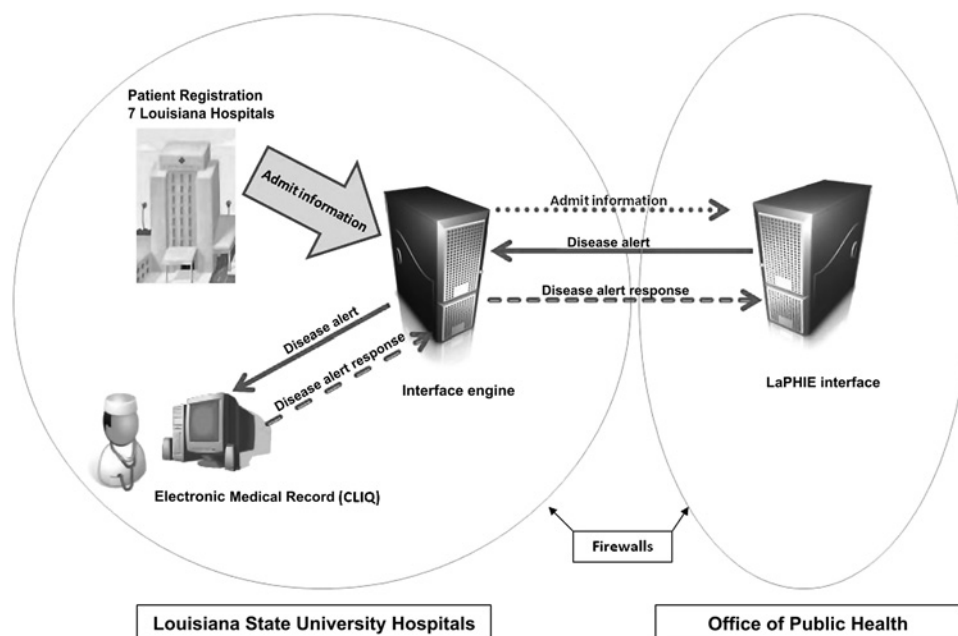
#### LaPHIE message flow

LaPHIE functionality is enabled by the integration of the disparate surveillance and clinical information systems of LSU HCSD and OPH which are now connected via a secure point-to-point tunnel over a designated wide area network connection (figure 1).

Demographics collected at registration for a clinical encounter flow in real time from the IDN's Admit Discharge Transfer system via an HL7 interface and open-source interface engine to a LaPHIE server at OPH where the LaPHIE matching algorithm is applied. The IDN's patient demographics are tested against the OPH LaPHIE data set to determine in real-time if the registered patient is an individual for whom a LaPHIE alert should be issued. In order to reduce error of issuing an alert on the wrong patient, patient data must match exactly with the last name, first name, date of birth, and social security number of a record in the OPH LaPHIE cohort. When records match exactly, a LaPHIE alert message, issued as a standard HL7 Patient Problem (PPR) message, is sent back to CLIQ where the LaPHIE alert is presented to providers on the opening screen of the patient's record—The Patient Summary Screen. Alerts are only visible to nurse and physician security roles to limit visibility to those clinicians with a specific informational need and who are in a position to take action. When clinicians see the alert, they have an option to *Take Action Now* or *Take Action Later*. When they select *Take Action Now*, they are directed to a screen—LaPHIE Intervention Note—that includes the clinical support recommendations outlined earlier and a structured documentation tool to record the clinical actions taken (figure 2).

Clinician actions taken are committed to the CLIQ repository and upon patient discharge, are sent to OPH via a standard HL7 Patient Problem Response (PPR) message. Logic is applied to the PRR messages to determine if the actions taken are sufficient to remove individuals from the OPH data set of out-of-care persons, or if they should remain as a person still in need of follow-up treatment. When a provider selects to take action

**Figure 1** Message flow. LaPHIE, Louisiana Public Health Information Exchange.



**Figure 2** The Louisiana Public Health Information Exchange (LaPHIE) Intervention Note.

CLIQ v1.0.26 - 3.31  
**CLIQ Clinical Inquiry**

Welcome, Jane Herwehe, Physician, Tue, May 25, 2010

Back | Forward

Patient Summary  
 Problem List  
 Demographics  
 Visit History  
 Medications  
 Immunizations  
 Laboratory  
 Pathology  
 Write Quick Note  
 Print

Patient Name: HIV2 ZzzTest 1 | MRN: HIV20  
 Age: 2X Years (XX/XX/XXXX) | Gender: Female

Patient may require follow up

**Details: Intervention Needs for HIV**

The Louisiana Office of Public Health records indicate that this patient has HIV, but does not appear to have accessed HIV-related medical care in at least the last 12 months. No CD4 or viral load test results have been received by OPH from public or private laboratories.

Please proceed with the Recommended Actions for Intervention.

Recommended Actions	Actions Taken
Assess need for intervention Offer education Assess patient and need for treatment Initiate treatment and monitoring plan Verify pregnancy or breastfeeding status	Please check the actions that you are completing with the patient. Some actions may already contain a check indicating completion by another provider. Other actions may not apply and can be left blank. Please hit SAVE once you have completed your actions. <input checked="" type="checkbox"/> Discussed OPH message and need for treatment with the patient <input type="checkbox"/> Re-ordered confirmatory Western Blot <input checked="" type="checkbox"/> Assessed stage of illness <input checked="" type="checkbox"/> Scheduled/Referred for follow up appt <input type="checkbox"/> Counseled pregnant patient (if needed) <input type="checkbox"/> Documented patient report of receiving treatment at another site <input type="checkbox"/> Confirmed patient is not interested in treatment at this time <input type="checkbox"/> Patient admitted

Comments:

CDC Website... Save

The Delta AIDS Education & Training Center is available for training regarding HIV/AIDS at 504-963-0788; any questions about HIV/AIDS can also be addressed by calling 504-963-0623

later, the alert continues to post with each return to the Patient Summary Screen, alerting the provider that action is still needed. Alerts responded to are turned off at patient discharge. When an alert triggers, an email notification simultaneously posts to LSU HCSD personnel assigned to monitor LaPHIE to avoid missed opportunities when a provider chooses to *Take Action Later* or ignores an alert. Should an alert lack response, a unit supervisor can communicate to staff the need to follow-up with the patient.

Implementation was phased into the LSU HCSD IDN by clinical venue and by hospital, starting with emergency departments in February 2009, and rolled out to all seven LSU HCSD hospitals by September 2009. A total of 442 clinicians (206 physicians and 236 nurses) were initially trained and serve as peer trainers.

### Formative evaluation of provider and patient acceptability

Clinician acceptability was evaluated throughout the intervention. Interviews were conducted with clinician and public health end-users prior to launch to measure concerns regarding confidentiality and exchange of sensitive information; these revealed support for the project, with the perception it would improve the care of both individual patients and the community. LaPHIE EMR alerts were designed with input from clinicians and public health personnel through an iterative prototype design process as well as clinician 'cognitive walk through' of the alert and CDS for evaluation of usability. In order to increase the acceptability and usability of the LaPHIE clinical messaging component, principles of participatory design and heuristic evaluation were utilized in the development of the LaPHIE Intervention Note. Components were rated on the following modified Nielsen-Schneiderman heuristics principles: Consistency, Visibility, Match, Complexity, Memory, Message, and Language.<sup>18</sup>

During development, the LaPHIE project team conducted focus groups (16 groups, n=149) and 23 key informant interviews with patients with HIV or other potentially life threatening and/or stigmatizing conditions who were infrequent users of healthcare. The purpose of the qualitative research was to

measure affected individuals' opinions on the purpose and structure of this potentially controversial exchange of protected health information.

### RESULTS

As shown in table 1, between 2/1/2009 and 1/31/2011, LaPHIE processed registration messages for 488 patient encounters and successfully identified, matched exactly, and exchanged messages on 345 unduplicated, HIV-positive patients in need of treatment. Clinicians responded to 73% of the alerts presented by documenting actions taken on the LaPHIE Intervention Note.

Using OPH surveillance data and LSU EMR data, these identified individuals are being followed over time. Of these, 60% were  $\geq 35$  years old, 72% were African American/Black, and 62% were male. Of males, 22% acquired HIV through men having sex with men (MSM) behavior. Of women and men not reporting MSM exposure, 27% were infected via heterosexual contact and 66% had unknown risk (data not shown). These messages were viewed by 192 providers (51% physicians; data not shown). Three-quarters (76%) of the patients were aware of their HIV status but had not received care for >12 months. Of these, 68% had evidence of at least one visit to a non-HIV clinic since being diagnosed with HIV, representing missed opportunities to link these patients with treatment. Of those with known HIV status, the median time from last visit to point of identification by LaPHIE was 20 (IQR 15–36) months. The majority (82%) followed up with HIV care within the study period, with 82% receiving at least one CD4 count during the 18-month follow-up study period and 62% having at least one HIV specialty visit. Ongoing research will assess the proportion of reengagement over time as more follow-up time accrues.

### Provider and patient acceptability

As part of implementation, feedback mechanisms were built in for clinicians to communicate with project team members and clinicians are also spontaneously contacting project staff. Comments have included suggestions for what additional uses

**Table 1** Characteristics of the LaPHIE system, February 2009 through January 2011

	N	%
Characteristics of alerts		
Alerts issued	488	
Of these, alerts issued to providers on time without technical delay*	405	83
Of these, encounters with documented clinician action in alert	294	73
Alerts per person, mean (SD), range	1.43 (0.89), 1–7	
Specific actions documented (could be more than one)		
Any action taken	315	78
Scheduled and referred	206	65
Discussed importance of treatment	164	52
Assessed disease stage	81	26
Obtained more lab tests	34	11
Commented in system	31	10
Admitted	22	7
Not interested in treatment	18	6
In treatment elsewhere	15	5
Other action	27	9
Characteristics of identified patients		
Unique patients linked into surveillance system	345	
Previous HIV diagnosis but never received CD4 or viral load monitoring	84	24
Previous HIV care >12 months prior to identification date	261	76
Median time from last visit to point of identification by LaPHIE, months (median, IQR)	20 (15–36)	
Any follow-up CD4 or HIV viral load test in study period	283	82
Of those who had been out of care >12 months, had at least one CD4 count	183	83

\*21 additional alerts were acted upon despite a delay of >2 h.

and other aspects of the LaPHIE Intervention Note they would like added over time. No negative feedback has been received from providers.

Patient acceptability is a critical facet of LaPHIE. Results of acceptability evaluation revealed that: (a) there was general acceptance, indicating support for the proposed secure electronic exchange; (b) the information should only be shared between public health and healthcare providers when there was benefit to the patient and/or the community; and (c) the healthcare delivery setting was the desired environment for communication of these diagnoses and need for follow-up, rather than the traditional community-based outreach methods used by public health. Qualitative post-intervention interviews were conducted with 20 HIV-infected persons identified via LaPHIE. Content analyses of these data reveal consistency of theme, with those identified individuals expressing acceptance and recognizing the value of the system.

## CHALLENGES

Challenges encountered with LaPHIE during design, development, and implementation were substantially less than expected relative to the extensive nature of the initiative. These challenges were largely philosophical in nature and concerned the ethics of the project. For example, there were diverse philosophies, perspectives, and policies among public health and healthcare practitioners. The process of data sharing and articulating issues concerning data ownership and understanding and agreeing on methods to legally and ethically protect sensitive protected health information and HIV diagnoses were key

components of the dialogue prior to implementation, as the IDN and State strove to balance individual rights and protection of the public's health. Other issues included characterization of the strengths and limitations of surveillance data for clinical decision making, disparate technical infrastructures and resources, and communication among providers. However, with continued success in linking patients into treatment for HIV, these challenges have rapidly become the system's strengths. The effort put forth by all stakeholders to build consensus and a commitment to protecting patients and public health has been shown to be enormously valuable. The participatory approach and the thoughtful, deliberate process to shared decision making between public health and healthcare delivery stakeholders when surmounting these challenges provided the foundation for success.

## DISCUSSION

LaPHIE demonstrates that real-time, bidirectional electronic information exchange can bridge public health and healthcare delivery, effectively leveraging EMR-based public health alerts, and linking patients into care. Preliminary analyses of LaPHIE reveal its efficacy at increasing linkage and retention in care, systematically improving individual and public health in one of the states most heavily impacted by the HIV epidemic.

Providers are responding to LaPHIE alerts at a higher rate than usually observed. Previous research has demonstrated that clinicians responded to 'public health situational awareness' alerts at rates of 2–65%.<sup>19</sup> One critical factor identified as most influencing response to alerts is specificity.<sup>20</sup> Furthermore, integrating contextually relevant information at the point of care has been shown to improve compliance with preventive care measures.<sup>21–23</sup> LaPHIE alerts are patient specific, only issued on those in need of treatment and integrated into the work flow. Use of the iterative prototype design approach incorporating usability study findings has ensured LaPHIE meets all of the goals of any reminder system: 'right information, right time, right person, right format.'<sup>21</sup> More formalized qualitative interviews evaluating system value will examine implementation, utilization, integration in and impact on work flow, use of the LaPHIE Intervention Note, impact on patients, and overall system satisfaction. A purposive sample of at least 10% of clinicians exposed to LaPHIE alerts will be interviewed as part of the demonstration evaluation methodology.

The costs of the system are currently being evaluated. After development and initial evaluation efforts, resources (minimal personnel) to monitor the functioning of the system at the healthcare delivery and public health sides of the exchange are needed as are resources to grow the system as new opportunities to expand use are identified. Costs associated with all directly funded and in-kind personnel as well as infrastructure costs (hardware, network management) have been documented; the cost savings and cost effectiveness of the program have not yet been determined given that evaluation is still ongoing. Models to be used to quantify these will include cost savings associated with prevention of morbidity from patients entering care at an advanced stage of HIV disease as well as costs saved through the prevention of HIV transmission. Discounted lifetime costs to provide treatment for a patient with a CD4 cell count of <350 are estimated at \$385 200 and undiscounted costs as high as \$618 900 (\$2100 per month, life expectancy 24.2 years).<sup>24</sup> There is evidence that the annual costs of treatment and care are less for those who initiate treatment with higher CD4 counts.<sup>25–27</sup> Potential savings per HIV infection prevented have been estimated at \$266 600 (2004 dollars).<sup>24 28</sup> Efforts such as LaPHIE

will require additional public health and healthcare resources which are expected to contribute cost savings associated with healthier HIV patients and fewer new infections.

HIE defined as 'organized entities that specialize in facilitating electronic HIE among a diverse group of often competing healthcare system stakeholders, such as hospitals and physician practices',<sup>16</sup> has yet to be achieved in Louisiana. Nascent efforts are underway at the state and regional levels. Ideally, a public health informatics solution such as LaPHIE should reside within the infrastructure of a formalized HIE as the broker which could 'serve up' LaPHIE logic and CDS components on identified patients. LSU HCSD and OPH have built a system to address the issues of linkage and retention in care for persons with HIV which now can be customized to address other public health issues. The future system evolution will allow this approach to be scaled to a larger population base as disparate healthcare providers join a state or regional HIE and are identified as targets for this strategy.

## CONCLUSION

The LaPHIE partnership has emerged as an example of how public health agencies and healthcare delivery organizations can share information to improve patient care and protect population health. Healthcare providers, as well as affected patients, have embraced the importance of LaPHIE in addressing the HIV epidemic in Louisiana. This innovative use of HIE is a critical step in curtailing the spread of infectious diseases and holds promise for extension to other providers, locations, and diseases. As of this writing, alerts for persons in need of tuberculosis follow-up have been implemented with similar acceptability and positive impact as those for HIV. While the exchange connects one IDN and the State's public health authority, the project team is currently developing an extensible platform for replicability of the LaPHIE components within a private IDN in Louisiana. Subsequently, this EMR vendor-independent platform could be used by multiple healthcare providers and public health entities.

**Acknowledgments** The authors thank staff members of the Louisiana Office of Public Health (STD/HIV and tuberculosis programs), the Louisiana State University (LSU) Health Care Services Division, the LSU Health Sciences Center, the LSU School of Public Health, and the Louisiana Public Health Institute who contributed conceptual, technical, and data management support for the Louisiana Public Health Information Exchange. In addition, the authors would like to thank Dr Michael K Butler, Executive Vice President and Chief Medical Officer of the Jackson Health System, Miami, Florida, for his support during the conceptual design of LaPHIE while serving as the Chief Medical Officer for LSU HCSD.

**Funding** This project is supported in part by U.S. Department of Health and Human Services, Health Resources and Services Administration, HIV/AIDS Bureau, Grant #H97HA08476.

**Competing interests** None.

**Ethics approval** The Institutional Review Boards of the Louisiana State University Health Sciences Center, The George Washington University Medical Center, and the Louisiana Department of Health and Hospitals (for the Louisiana Office of Public Health) approved this study.

**Provenance and peer review** Not commissioned; externally peer reviewed.

## REFERENCES

1. **CDC.** *HIV Surveillance report: Diagnoses of HIV Infection and AIDS in the US and Dependent Areas.* 2009. <http://www.cdc.gov/hiv/surveillance/resources/reports/2009report>
2. **2009 HIV/AIDS Program Report.** Louisiana: Department of Health and Hospitals, Office of Public Health. [http://www.dhh.state.la.us/offices/publications/pubs-264/FINAL\\_2009\\_AR\\_PDF.pdf](http://www.dhh.state.la.us/offices/publications/pubs-264/FINAL_2009_AR_PDF.pdf)
3. **Marks G, Crepac N, Senterfitt JW, et al.** Meta-analysis of high-risk sexual behaviors in persons aware and unaware they are infected with HIV in the United States: implications for HIV prevention programs. *J Acquir Immune Defic Syndr* 2005;**39**:446–53.
4. **Metsch LR, Pereyra M, Messinger S, et al.** HIV Transmission risk behaviors among HIV-infected persons who are successfully linked to care. *Clin Infect Dis* 2008;**47**:577–84.
5. **Cohen MS, Chen YQ, McCauley M, et al.** Prevention of HIV-1 infection with early antiretroviral therapy. *NEJM* 2011;**365**:493–505.
6. **De Cock KM, Gilks CF, Lo YR, et al.** Can antiretroviral therapy eliminate HIV transmission? *Lancet* 2009;**373**:7–9.
7. **Granich RM, Gilks CF, Dye C, et al.** Universal voluntary HIV testing with immediate antiretroviral therapy as a strategy for elimination of HIV transmission: a mathematical model. *Lancet* 2009;**373**:48–57.
8. **Shapiro JS, Kannry J, Kushniruk AW, et al.** Emergency physicians' perceptions of health information exchange. *J Am Med Inform Assoc* 2007;**14**:700–5.
9. **Rudin RS, Simon SR, Volk LA, et al.** Understanding the decisions and values of stakeholders in health information exchanges: experiences from Massachusetts. *Am J Public Health* 2009;**99**:950–5.
10. **Overhage JM.** Health information exchange: 'lex parsimoniae'. *Health Aff (Millwood)* 2007;**26**:w595–7.
11. **Frisse ME, King JK, Rice WB, et al.** A regional health information exchange: architecture and implementation. *AMIA Annu Symp Proc* 2008:212–16.
12. **Frisse ME.** Health information exchange in Memphis: impact on the physician-patient relationship. *J Law Med Ethics* 2010;**38**:50–7.
13. **Vest JR, Gamm LD.** Health information exchange: persistent challenges and new strategies. *J Am Med Inform Assoc* 2010;**17**:288–94.
14. **Vest JR.** Health information exchange and healthcare utilization. *J Med Syst* 2009;**33**:223–31.
15. **Wright A, Soran C, Jenter CA, et al.** Physician attitudes toward health information exchange: results of a statewide survey. *J Am Med Inform Assoc* 2010;**17**:66–70.
16. **Dixon BE, Zafar A, Overhage MJ.** A Framework for evaluating the costs efforts, and value of nationwide health information exchange. *J Am Med Inform Assoc* 2010;**17**:295–301.
17. **Wilbright WA, Marier R, Abrams A, et al.** Building a results review system: a critical first step in transitioning from paper medical records. *AMIA Annu Symp Proc* 2005:819–23.
18. **Nielsen J.** Heuristic evaluation. In: Nielsen J, Mack RL, eds. *Usability Inspection Methods.* New York, NY: John Wiley & Sons, 1994.
19. **Lurio J, Morrison FP, Pichardo M, et al.** Using electronic health record alerts to provide public health situational awareness to clinicians. *J Am Med Inform Assoc* 2010;**17**:217–19.
20. **van der Sijs H, Aarts J, Vulto A, et al.** Overriding of drug safety alerts in computerized physician order entry. *J Am Med Inform Assoc* 2006;**13**:138–47.
21. **Dexheimer JW, Talbot TR, Sanders DL, et al.** Prompting clinicians about preventive care measures: a systematic review of randomized controlled trials. *J Am Med Inform Assoc* 2008;**15**:311–20.
22. **Frank O, Litt J, Beilby J.** Opportunistic electronic reminders: improving performance of preventive care in general practice. *Aust Fam Physician* 2004;**33**:87–9.
23. **Garrett N, Yasnoff WA.** Disseminating public health practice guidelines in electronic medical record systems. *J Public Health Manag Pract* 2002;**8**:1–10.
24. **Schackman BR, Gebo KA, Walensky RP, et al.** The lifetime costs of current human immunodeficiency virus care in the United States. *Med Care* 2006;**44**:990–7.
25. **Beck EJ, Mays N.** Some lessons learned. In: Beck EJ, Mays N, Whiteside A, et al, eds. *The HIV Pandemic: Local and Global Implications.* Oxford UK: Oxford University Press, 2006:769–72.
26. **Krentz HB, Gill MJ.** Cost of medical care for HIV-infected patients within a regional population from 1997-2006. *HIV Med* 2008;**9**:721–30.
27. **John A, Fleishman JA, Yehia BR, et al.** HIV Research Network. The economic burden of late entry into medical care for patients with HIV infection. *Med Care* 2010;**48**:1071–9.
28. **Holtgrave DR, Pinkerton SD.** Updates of cost of illness and quality of life estimates for use in economic evaluation of HIV prevention programs. *J Acquir Immune Defic Syndr Hum Retroviro* 1997;**16**:54–62.